

# Diaphragmatic suture with tubular stomach to prevent early delayed gastric emptying after esophagectomy

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## Abstract

**Objective** The objective of this study was to evaluate the clinical efficacy of a diaphragmatic suture with tubular stomach to prevent delayed gastric emptying (DGE) after esophagectomy through the cervico-thoracoabdominal approach.

**Methods** A total of 980 patients with esophageal cancer undergoing esophagectomy through the cervico-thoracoabdominal approach were retrospectively included in this study and divided into two groups. All patients underwent tubular stomach creation (group A;  $n = 530$ ) or a diaphragmatic suture and tubular stomach creation (group B;  $n = 450$ ). The incidence of early DGE was observed.

**Results** The incidence of early DGE in group A was significantly higher than that in group B ( $P < 0.05$ ).

**Conclusion** This observation study suggests that the use of a diaphragmatic suture with tubular stomach through the cervico-thoracoabdominal approach can decrease the incidence of early DGE after esophagectomy.

**Key words:** esophageal cancer; esophagectomy; delayed gastric emptying (DGE); tubular stomach; complications

Received: 4 April 2015  
Revised: 23 May 2015  
Accepted: 25 June 2015

Esophagectomy through the cervico-thoracoabdominal approach is a useful surgical technique in the treatment of patients with esophageal cancer. This approach facilitates three-field lymph node dissection, leading to a high feasibility of complete resection of the primary tumor and the removal of metastatic nodes [1–3]. To date, thoracic surgeons have gradually performed such operations with tubular stomach instead of whole stomach [4], and since this surgical technique is more consistent with the patients' physiological condition, its use significantly improves their postoperative quality of life [5–6]. However, postoperative early delayed gastric emptying (DGE) is a troublesome complication [7–8] for which there is currently no effective treatment method [9–10]. We have tried many methods to prevent early DGE and found that the use of a diaphragmatic suture with tubular stomach during esophagectomy is conducive to its prevention. This study aimed to evaluate the clinical efficacy of a diaphragmatic suture with tubular stomach for preventing DGE after esophagectomy using the cervico-thoracoabdominal approach.

## Materials and methods

### Clinical data

Between June 2009 and July 2013, 983 esophageal cancer patients undergoing esophagectomy through the cervico-thoracoabdominal (three-field) approach in the Northern Jiangsu People's Hospital were retrospectively analyzed. Complications-related postoperative deaths were excluded from the analyses. A total of 980 cases were selected for this study, and all surgeries were performed by the same group of surgeons. Patients were divided into two groups: Group A included a total of 530 patients who underwent surgery prior to October 2011 who were given no particular treatment during the surgery, whereas Group B included a total of 450 patients who underwent surgery after October 2011 that consisted of a diaphragmatic suture and tubular stomach. The demographic information of the two patient groups is shown in Table 1. Patients included in this study received neither preoperative radiotherapy nor chemotherapy. The diagnosis of esophageal cancer was made by an upper gastrointestinal

**Table 1** Patients' demographic data (n)

Characteristic	Group A	Group B	P value
Age (years)	58.2 ± 11.5	58.5 ± 12.8	> 0.05
Gender			> 0.05
Male	143	328	
Female	387	122	
Staging			> 0.05
I	97	68	
II	260	234	
III	136	127	
IV	37	21	
Locations			> 0.05
Upper	63	43	
Middle	382	343	
Inferior	85	64	

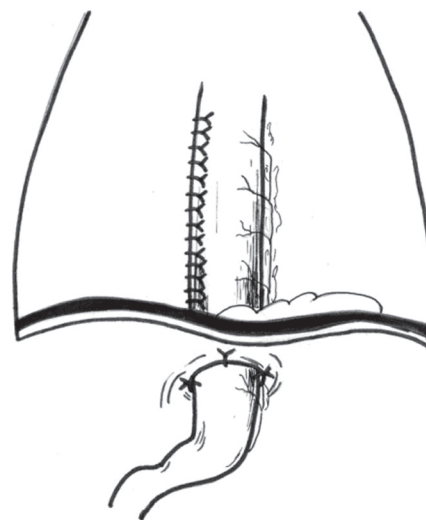
barium meal and gastroscopy.

### Operative methods

All patients underwent esophagectomy through right thorax, left cervical, abdominal triple incisions and cervical reconstruction by hand-sewn two-layer anastomosis with wild lymph node dissection. All patients underwent tubular stomach creation. The tubular stomach was formed from the distal aspect of the lesser curvature of the stomach using linear staples. It was created by resection of the lesser curvature of the stomach. Formation of the gastric conduit (4–5 cm in diameter) was based on preservation of the gastroepiploic vessels of the greater curvature of the stomach. The tubular stomach was pulled upward to the left cervical part through the posterior mediastinal route and secured using a hand-sewn two-layer anastomosis. During the operation, the distal stomach must be fully freed to ensure that the pylorus is in a state of relaxation after the tubular stomach was pulled upward to the left cervical part. The diaphragmatic hiatus was expanded to at least three fingers during the operation. The patients in Group A received no other treatment during the operation, whereas those in Group B underwent suturing of the seromuscular layer of the tubular stomach with muscles of the diaphragmatic hiatus using three stitches after the cervical anastomosis (Fig. 1).

### Postoperative determination of early DGE

Gastrointestinal peristalsis would slow down or disappear and the patient would usually recover in 3–5 days after the surgery. Early DGE was considered when the following symptoms were noted: dilated intrathoracic stomach > 5 days postoperatively on chest radiography; fluid retention within the stomach; or chest tightness, nausea, or brown gastric juice vomit. These symptoms would disappear after gastrointestinal decompression but reappear upon gastric tube closure. All of the patients underwent an iohexol swallow study 6 days after the opera-



**Fig. 1** Sutured seromuscular layer of the tubular stomach with the diaphragmatic hiatus muscles using three stitches

tion. If none or only a small amount of the contrast agent can pass through the pylorus, postoperative early DGE is diagnosed.

### Statistical analysis

Normally distributed continuous data such as age are presented as mean and standard deviation and compared with Student's *t*-test. Differences between proportions such as disease staging, tumor location, and the incidence of early DGE were compared using the Chi-squared test. *P* values < 0.05 were considered statistically significant. The statistical software package SPSS 16.0 was used for all calculations on a standard personal computer.

### Results

There were no cases of perioperative death in either group. The patient characteristics did not differ significantly between the two groups (*P* > 0.05). The incidence of early DGE was 0.44% (2/450) in Group B and 3.02% (16/530) in Group A, a significant difference (*P* = 0.003). After early DGE was diagnosed, 14 patients in Group A and two in Group B underwent balloon dilatation of the pylorus through digital subtraction angiography (DSA) and recovered. Two patients in Group A did not improve after the dilatation therapy and underwent surgery. During surgery, we found that the pylorus of each patient was pulled upward and severely deformed. A pyloroplasty was performed and both recovered uneventfully.

### Discussion

In this observational study, we found that patients who

underwent the creation of a diaphragmatic suture with tubular stomach during esophagectomy using the cervico-thoracoabdominal approach had a lower incidence of postoperative early DGE.

Surgeons have paid increasingly more attention to the assessment of postoperative quality of life of patients with esophageal cancer. The condition of health-related quality of life has become one of key factors in the evaluation of surgical treatment, such as DGE, intrathoracic stomach syndrome, and reflux esophagitis, all of which seriously affect patient postoperative quality of life [11].

In this study, all patients underwent tubular stomach creation, which showed a lower incidence of intrathoracic stomach syndrome and reflux esophagitis than that with the whole stomach in previous studies. In traditional esophagectomy procedures using the whole stomach, gastric peristalsis decreases after placement in the thoracic cavity, which can induce gastric dilation or produce intrathoracic stomach syndrome. Zhang C [12] found that the use of tubular stomach can decrease the incidence of intrathoracic stomach syndrome. Meanwhile, food intake and digestive function were equivalent between patients with tubular stomach and those with a whole stomach. However, in the clinical setting, we find that some patients still suffered from DGE, primarily due to changes in the pylorus [13]. As such, we believe that DGE can be solved if we appropriately manage the changes in pylorus shape.

As soon as early DGE was diagnosed, most patients who underwent balloon dilatation of the pylorus via DSA recovered soon thereafter [14]. When patients with DGE underwent the iohexol swallow study, almost all demonstrated serious intrathoracic stomach expansion due to the existence of negative pressure within the chest cavity and diaphragmatic hiatus expansion because the stomach gradually enters the chest cavity through the expanded diaphragmatic hiatus. The dilated stomach will hang in the right lower chest cavity and is severely pulled upward, which leads to the severe pylorus deformity. As such, we believe that this is the main cause of postoperative early DGE, and in the esophagectomy using the cervico-thoracoabdominal approach, we sutured the diaphragm with the tubular stomach to decrease the incidence of postoperative early DGE. The chest X-ray examination and iohexol swallow study in patients with postoperative early DGE revealed that if the intrathoracic gastric dilatation and the pulled-up height of the pylorus are more serious, then it is more difficult to pass the guide wire through the pylorus during balloon dilatation of the pylorus via DSA and recover the gastric emptying. This procedure requires several courses of balloon dilatation therapy, and some patients even require open abdominal surgery with pyloroplasty [15].

Considering the abovementioned causes of DGE, we

mainly adopt the following measures to prevent it and analyze the feasibility. (1) We suture the diaphragm with tubular stomach during esophagectomy using the cervico-thoracoabdominal approach to prevent severe pylorus deformity because the stomach is pulled upward in the abdomen after surgery. (2) We have performed such operations with tubular stomach instead of whole stomach to increase the stomach's length and guarantee containment of the antrum of the stomach and the pylorus completely within the abdominal cavity. At the same time, it can reduce the width of the stomach in the thoracic cavity, which will prevent intrathoracic gastric dilatation and reduce the pylorus height [16]. (3) The diaphragmatic hiatus should be expanded to at least three fingers during the operation, and the bilateral crura of the diaphragm in particular should be cut to prevent mechanical obstruction caused by diaphragmatic muscle contraction. (4) Enteral nutrition will be given 1 day after the operation to contribute to the recovery of intestinal function [17].

This study reveals that the use of a diaphragmatic suture with tubular stomach can decrease the incidence of early DGE after esophagectomy using the cervico-thoracoabdominal approach. However, this surgical technique requires wider application and greater refinement.

### Conflicts of interest

The authors indicated no potential conflicts of interest.

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**DOI 10.1007/s10330-015-0086-8**

**Cite this article as:** Sun C, Shi WP, Shu YS, *et al.* Diaphragmatic suture with tubular stomach to prevent early delayed gastric emptying after esophagectomy. *Oncol Transl Med*, 2015, 1: 280–283.